

## NATURAL RESOURCES

Isle Royale National Park is a forested archipelago surrounded by the cold, deep waters of Lake Superior. The land base is comprised of one large island surrounded by several hundred smaller islands. Boreal and northern hardwood forests dominate the landscape cover. Over 75% of the park acreage is water and includes Lake Superior and many lakes, ponds, bogs, marshes, and streams.

### SPECIAL DESIGNATIONS

#### Wilderness

Public Law 94-567, approved October 26, 1976, designated 131,880 acres of the land base of Isle Royale as wilderness. An additional 231 acres were designated as potential wilderness. Thus, some 99% of the land base is designated as wilderness. This law requires Isle Royale National Park to manage the land in designated wilderness in accordance with the provisions of the Wilderness Act of 1964 (PL 88-577).

The Wilderness Act defined wilderness as “an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain.” The law further defined wilderness as an area “of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural condition and which . . . generally appears to have been affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable; . . . has outstanding opportunities for solitude or a primitive and unconfined type of recreation.”

These definitions of wilderness have considerable implications for management in NPS units. Most notable is the following from NPS *Management Policies* (chapter 6:3): “Within a designated wilderness area, the preservation of

wilderness character and resources while providing for appropriate use is the primary management responsibility (other than activities related to the saving of human life).” For Isle Royale, this wilderness preservation mandate applies to all the designated wilderness. NPS policy stipulates that land currently under potential wilderness designation is to be managed as wilderness.

#### U. S. Biosphere Reserve

Isle Royale was formally designated as a U.S. biosphere reserve in 1980 through the Man and the Biosphere Programme (MAB) of the United Nations Educational, Scientific, and Cultural Organization. This program is an international effort to protect examples of major ecosystems that provide a baseline of conditions against which human impact can be assessed. Isle Royale is one of almost 50 U.S. reserves, a majority of which are found in NPS units. Isle Royale is in the lake systems biome.

The biosphere reserve model includes a protected core zone where natural ecosystem function is largely protected and intact, a buffer zone surrounding the core in which some landscape manipulation occurs, and an intensively manipulated zone surrounding the buffer zone in which there is considerable development and economic activity. Isle Royale’s participation in the MAB program has been limited, largely because only one of the three zones is represented — the protected core area.

Nonetheless, the value of Isle Royale as an ecosystem baseline to monitor natural systems and human impacts has been recognized and documented, thus fulfilling some of the objectives of the MAB program. There are several long-term ecological monitoring efforts underway in the park, and the first widespread recognition of the role of atmospheric transport

of contaminants into the natural environment arose from research at Isle Royale.

There are ongoing efforts in the broader Lake Superior basin to extend the biosphere reserve concept to include all or part of Lake Superior. Isle Royale would serve an integral role in such a reserve as a core protected area within a broader managed landscape.

## VEGETATION

Approximately 700 species of vascular plants are found at Isle Royale (Slavick and Janke 1993), of which slightly over 100 species (15%) are nonnative (Judziewicz 1995a). Most park land is covered by a continuous forest, broken only by marshlands or open bedrock ridges of brush and grass. Preliminary information from an ongoing vegetation mapping project has identified at least 30 different vegetation alliances on the island. Many examples of forest succession are evident on the island following fire, insect outbreaks, windthrow, and browsing as well as along shorelines.

Two major forest biomes are represented on the island (Linn 1966) — the boreal coniferous forest and the northern hardwoods forest. Lake Superior strongly influences the island climate; this influence in turn largely determines the forest vegetation patterns on the island. The cold Lake Superior water surrounding Isle Royale both cools and moistens the shorelines. Farther inland and upland this influence wanes, and drier, warmer conditions prevail. These two climates have produced two forest types — the boreal forest nearer the shoreline and the northern hardwoods of the interior uplands. Elements of each type are found across the island, but because the east end is narrow (averaging only 3–5 miles wide) and has shallow soils, the boreal forest is widespread there. On the west end, where the island is about 8 miles wide and soils are deeper, the northern hardwoods forest associated with drier, warmer conditions is more widespread.

The boreal forest includes balsam fir, white spruce, white birch, and aspen; mountain ash is also present, but less common. Common understory species are thimbleberry, large-leaved aster, and Canada dogwood.

The northern hardwoods forest, found in the interior uplands, is typified by the sugar maple-yellow birch forest. The large sugar maple forest centered on Greenstone Ridge on the west end is perhaps the largest tract of undisturbed and unaltered forest on Isle Royale. Northern red oak also is found on dry hillsides. Under the sugar maple overstory a dense undergrowth of sugar maple seedlings has developed. Herbaceous species include trillium, yellow clintonia, and twisted stalk.

Other significant forest types include jack pine stands, typically found on dry, open ridges and bluffs with a past history of fire. White and red pine also are found but generally as individuals or in small patches, often along ridges or lake shorelines.

Wetland environments (beaver ponds, bogs, swamps, and marshes) are common on the island and are characterized by specialized vegetation. The ridge/valley topography has created swamp environments in most of the valleys. Beaver ponds can cause standing dead forests, but swamps that have developed without the beaver influence typically include white cedar or black spruce. Tamarack, once more widespread, is restricted today to scattered individuals in some swamps. Speckled alder is common in swamps as well.

There are two major bog types on the island. Sphagnum bogs are dominated by the sedge *Carex limosa*, have little or no drainage, and have sphagnum moss, labrador tea, black spruce, and tamarack as common species. Cyperaceous bogs are dominated by the sedge *Carex lasiocarpa*, often have an active water outlet, have less Labrador tea and sphagnum cover, and have tamarack and white cedar as overstory.

## Rare Species — Vegetation

There are no federally listed threatened or endangered plants at Isle Royale, although there are two species of concern, the auricled twayblade (*Listera auriculata*) and the ram's head lady slipper (*Cypripedium arietinum*) (USDI 1996).

Over 60 species of plants on the state of Michigan rare species list occur at Isle Royale (State of Michigan 1992). Locations of 102 rare plant species were documented on the island Judziewicz (1995b), all of which are (1) on the state list, and/or (2) are new findings in the state, and/or (3) are more common regionally but are known to be very rare on Isle Royale. Many of these species are found in the narrow, specialized rock shoreline habitat along Lake Superior.

## Arctic-Alpine and Western Disjunct Species

Several plant species found on Isle Royale are far removed from their present range; they are believed to have arrived on Isle Royale during post-glacial times and have survived along the cool, moist rock shorelines (Slavick and Janke 1993). Many of these species are on the state of Michigan rare species list. Perhaps the most visible of these species is thimbleberry, which is widespread throughout the island; most notable is devil's club, not found elsewhere east of its native range in western Montana.

## AIR QUALITY

The Clean Air Act (1977) designated Isle Royale as a class I airshed, which provides for the highest level of protection of air quality. Air quality remains a long-standing concern, as the health of this resource is so intimately linked to the other resources of the park.

Monitoring of some air quality conditions in the park was conducted beginning in the late 1980s, but lack of funding has caused the elimination

of most of that effort. Some baseline information exists for visibility monitoring and gaseous pollutants.

In 1991–92 visibility monitoring equipment operating in the park identified industrial sources of visible pollutants in the viewshed toward Thunder Bay, Ontario. The direct impact to park resources from these pollutants is unknown. Park staff have documented pulp and paper mill odors reaching the park from Thunder Bay, Ontario; on average, these odors reach the park 20% of the time during the visitor season.

The park continues to operate an acid deposition monitoring station to document trends. Acid deposition is not believed to be causing problems at this time.

Of greatest concern to the park are aerially transported toxic contaminants. Some of these contaminants include mercury, organochlorines, herbicides, and elemental sulfur and zinc. In 1993 lake trout in Siskiwit Bay exceeded the state consumption advisory for total chlordane, toxaphene, total PCBs, mercury, and total DDT (MDNR 1994a). The resurgence of bald eagle and osprey nesting in the park and the dramatic increase of double-crested cormorants are linked in part to lower levels of PCBs than in previous decades, but the effects of contaminants on the plant and animal life of Isle Royale remains largely unknown.

## WATER RESOURCES

Aquatic habitats account for more than 75% of the total park acreage, and cover a wide spectrum ranging from the deep, cold waters of Lake Superior to the inland lakes, streams, beaver ponds, marshes, and bogs of the island. The diversity of aquatic plant and animal life is tied to the health of the total park ecosystem, but (as with most other park resources) understanding and documentation remains sketchy. The park has no water resources management plan to

guide the management or monitoring of this resource.

### **Water Quality**

There has been limited water quality monitoring of the Lake Superior waters in the park; indirect monitoring, such as by analyzing contaminant levels in fish, indicates that contaminant levels remain a key concern. Mercury levels in common loons have been documented since the early 1990s (Evers, et al. 1996). Isle Royale loons in general exhibit lower levels of mercury than loons in most other parts of the country (particularly juvenile loons).

Knowledge of water quality in the inland waters is similarly limited, although recent and ongoing projects are providing more information. A companion effort to the 1995–97 inland lakes fishery inventory was the documentation of the baseline physical/chemical water conditions for the 32 lakes with sportfish.

Toxic contaminant levels in the inland lakes are a serious concern. Fish monitored in 1992–94 did not exceed the state of Michigan consumption advisory levels, but six of the 32 lakes sampled in the 1995–96 inland lakes fishery inventory included fish that exceeded the advisory level.

Water quality can be affected by oil and fuel discharges from boats. Sewage treatment capacity could become a problem if visitation increases. Also of concern are inadequate human waste disposal methods in the back-country and on the water from boaters with inadequate means of disposal.

### **Floodplains**

There has never been a formal determination of the floodplains on Isle Royale. In general, the short, low gradient streams on Isle Royale pose few flooding concerns, and the only facilities and developments believed to be near these

streams are campgrounds. Occasionally a beaver dam washout causes flash flooding in a stream segment. Of greater concern has been the rising and falling levels of Lake Superior, which have created concerns about erosion near park developments.

### **Wetlands**

There are a variety of wetland habitats, including bogs, swamps, beaver ponds, streams, and lakes ranging from a few acres to the almost 4,000-acre Siskiwit Lake. The U.S. Fish and Wildlife Service mapped these wetlands (using aerial photography) as part of the National Wetlands Inventory Program, and those maps are being incorporated into the park's geographic information system.

## **WILDLIFE**

### **Mammals**

The mammals of Isle Royale reflect the influence of an island ecosystem largely isolated from the continental mainland. Currently 14 mammal species are found on Isle Royale; the status of at least three additional species is largely unknown (the pine marten may be back on Isle Royale in very limited numbers). Many species common on the mainland, only 20–25 miles west, are not found on Isle Royale because they cannot swim across Lake Superior, do not cross on the occasional winter ice cover, or have not been introduced to the island by people. Several species have disappeared since post-European humans arrived on the island — most notably the caribou, coyote, and the lynx. At least two other species arrived on Isle Royale in the 20th century — the timber wolf and the moose.

This limited number of mammal species gives credence to a classic island biogeography theory (MacArthur and Wilson 1967), which argues that the number and diversity of species on islands is less than on mainland areas because

island species are dependent on distance from the mainland and the size of the island. Mammal colonizations of Isle Royale are by chance dispersal; natural extinction is always a possibility.

Two species that have profoundly influenced the island ecology in the 1900s are the timber wolf and the moose. Moose arrived in the early 1900s and with no significant predator to influence population growth, quickly reached population levels that outstripped the natural carrying capacity. After a significant population crash in 1934, the moose population slowly began to increase again. The arrival of wolves in the late 1940s brought a stabilizing influence to the moose population. Moose have had a profound impact on vegetation, almost completely eliminating some species, such as Canada yew, and over browsing other species, such as aspen, mountain ash, willow, birch, and balsam fir. These impacts ripple throughout the ecosystem and even extend to an alteration of the natural fire cycle, as the more flammable Canada yew has been replaced by the less flammable thimbleberry.

The wolf and moose populations have been the subject of perhaps the longest running predator-prey research and monitoring program in the world. Initiated in 1958 by Durward Allen of Purdue University and continued since the mid-1970s by Dr. Rolf Peterson of Michigan Technological University and the National Park Service, the 40th annual monitoring program will be completed in the winter of 1998. Much of what is known about wolves in the natural setting, free of human harassment, comes from the Isle Royale studies (Mech 1966, Peterson 1977, 1994).

Other mammals on the island include the red fox, snowshoe hare, mink, short-tailed weasel, beaver, deer mouse, and red squirrel. Three known bat species are found (little brown myotis, Keen's myotis, and the big brown bat myotis). A less common species is the muskrat. The river otter has increased substantially in numbers in the 1990s, which is probably closely

related to the upswing in herring populations around the island.

## Birds

Less affected by the isolation of Isle Royale are the avian species, which mirror those found on the mainland (with the exception of the ruffed grouse and spruce grouse, which cannot manage the long flight across Lake Superior). Park staff have increased the effort in the 1990s to monitor bird populations in the park; at present the park is actively monitoring bald eagle and osprey reproduction, forest songbird populations, common loon reproduction, and colonial waterbird populations. Here again, with the unaltered habitats that the island offers, the park can play a role in providing avian population information for comparison to the more altered ecosystems on the mainland.

Bald eagle and osprey populations continue to rise. Following the devastating effects of pesticides, which eliminated nesting of these species in the 1960s and 1970s on Isle Royale, both species began nesting in the park in the early 1980s. As of 1997 there were nine successful bald eagle nests and four successful osprey nests (National Park Service 1997a).

Forest songbird monitoring began in 1994; the most common include the white-throated sparrow, Nashville warbler, ovenbird, and the red-eyed vireo. In 1997, 58 species were recorded during the monitoring program (National Park Service 1997b).

Isle Royale has the only known common loon nesting activity on Lake Superior. Annual monitoring of chick production has been ongoing since 1990 for both Lake Superior and the inland lakes. The population appears to be stable, and research aimed at understanding the ecology of loons and the effects of mercury bioaccumulation in loons across the country includes data from the Isle Royale population (Evers, et al. 1996).

The colonial waterbird (great blue heron, double-crested cormorant, herring gull, and ring-billed gull) populations on the island appear healthy. Isle Royale has also witnessed the explosive growth experienced by the cormorant population since the late 1980s and has been seen throughout the Midwest.

Fifty peregrine falcon young were released in the park over a five-year period beginning in 1987, primarily along the Feldtmann Ridge. Although occasional sightings are made of individual birds in the park, no nesting has occurred.

### **Herpetofauna**

Little is known about the reptiles and amphibians of Isle Royale. Park staff began basic frog monitoring surveys in 1996 on the east end of the island, but no systematic work has been done since the mid-1960s. A long-term research effort focused on chorus frog tadpole populations has been ongoing for nearly 20 years, but that project is limited to the northeast end of the island.

There are three reptile (western painted turtle, red-bellied snake, and garter snake) and seven amphibian (blue-spotted salamander, American toad, spring peeper, chorus frog, green frog, mink frog, wood frog) species known on Isle Royale. The status of one other reptile (black rat snake) and two other amphibian (red-spotted newt and mudpuppy) species is in question.

The alarming decline in amphibian populations worldwide and concerns about amphibian deformities illustrate the need for good herpetofauna population information.

### **Fish**

The diverse fishery of the Lake Superior and inland waters of Isle Royale represent the most nationally significant natural resources in the park. The lake trout is recognized as the best

example of a rehabilitated lake trout population in Lake Superior. They are the most genetically diverse population in the lake. The coaster brook trout population, considered to be extremely rare, is the only known reproducing population in U.S. waters. Herring populations have rebounded in the park as they have elsewhere, enabling predators such as otters, eagles, osprey, common loons, and cormorants to improve. The fishery provides an outstanding opportunity for recreational fishing for many park visitors.

Jurisdiction over the fishery in Isle Royale is split; the state of Michigan manages and sets regulations for the Lake Superior fishery, and the National Park Service manages the inland lakes.

Much of the information on the Lake Superior fishery is focused on the lake trout. Information from the Sivertson commercial fishery on Washington Island, the Edisen Fishery in the Rock Harbor channel, the more than 30 years of net surveys by the Ashland Biological Station, and limited creel information indicates a generally healthy lake trout population. Park staff are actively working with the professional fishery managers in the Lake Superior basin to gather more information.

A regional cooperative effort involving the National Park Service, the U.S. Fish and Wildlife Service, several tribal agencies, and the states of Minnesota, Michigan, and Wisconsin is increasing knowledge of the rare coaster brook trout. A project to create a broodstock based on the Isle Royale coaster populations started in 1995. However, there remain serious concerns about the future of the Isle Royale coaster populations, and ongoing efforts will focus on acquiring more information on the park's populations.

Information on the status of the other fisheries in Lake Superior is much less extensive. Other fish species include herring, whitefish, suckers, sturgeon, northern pike, walleye, and yellow perch.

An intensive fishery inventory of the inland lakes was conducted from 1995–97. This information provides the first comprehensive update of the inland lakes fishery resource since the 1920s and will enable park management to assess the adequacy of the catch regulations. The project serves as an important baseline for the fishery and limnological resources in the inland lakes and includes data on mercury levels in the fish. Most recreational fishing of the inland waters focuses on northern pike, walleye, brook trout, and lake trout.

### Threatened and Endangered Species

Those animal species currently federally listed as threatened or endangered include the eastern timber wolf, *Canis lupus* (endangered), bald eagle, *Haliaeetus leucocephalus* (threatened), and the peregrine falcon, *Falco peregrinus* (endangered). Lynx (*Felis lynx*) have not been bred in the park since the 1930s. Any that may exist in the park are probably transient.

Several other species are on the “Michigan’s Special Animals” list (State of Michigan 1994b). The list is included as Appendix D.

### Others

There have been no comprehensive surveys of insects, snails, or mussels on Isle Royale.

### PHYSIOGRAPHY

Isle Royale National Park lies in the Superior Upland physical province (Shetron and Stottlemeyer 1991). Elevation ranges from 600 feet at Lake Superior to almost 1,400 feet along Greenstone Ridge. The physiography of the park is a product of glaciation modified by bedrock. The dominant features across the landscape are the ridge and valley topography with variable thicknesses of glacial drift deposits left from the last retreat of the continental glaciers about 10,000 years ago. There are many lakes and

ponds, and vast areas of swamps cover depressions in the landscape. Numerous low-gradient stream systems drain the interior of the island into Lake Superior.

Surficial deposits of glacial debris cover the island, ranging in thickness from over 5 feet near Lake Desor to less than 2 feet near the northeastern end of the island. Bedrock outcrops are common across the island.

Two major ridges parallel the long axis of the island, the Minong and Greenstone Ridges. Both ridges have steep escarpments with elevational differences of several hundred feet.

### GEOLOGY

Precambrian rock layers over one billion years old, the result of successive volcanism, sedimentation, uplift, and erosion, form the Isle Royale archipelago. The bedrock sequence on the island consists of thick layers of lava and sedimentary rocks that have been tilted toward the southeast, and the linear ridges of the island are the eroded edges of individual layers of the sequence (Huber 1975). Significant minerals found in the park include copper, greenstones, datolite, and agates.

Keweenaw volcanics dominate the geology of Isle Royale, with interbedded sediments exposed in the upwarping of the deposits that tilt toward the southeast and mirror the formations in the Keweenaw Peninsula that tilt toward the northwest (Clark 1995). Sedimentary deposits lie on the southwestern end of the island that have corresponding features on the south shore of Lake Superior as sandstones and conglomerates. Cutting across these beds are many transverse faults.

Glacial activity is visible throughout the island and includes abrasions on bedrock, quarrying of rocks by plucking, striations across the bedrock, deposits of glacial till (such as at the west end of Siskiwit Lake), and landscape features such as drumlins and moraines. Former lake levels of

Lake Superior are evidenced by inland beach ridges on the island.

## **SOILS**

A soil survey for Isle Royale was completed (Shetron and Stottlemeyer 1991). The research mapped and described 15 soil series, and 14 distinct soil associations were described. Three new soil series were included based on their development associated with the various lake levels in the Lake Superior basin, the decay and retreat of the glaciers, and the uplift of the land mass following glacial retreat.

The soils on Isle Royale are derived from deposits and outwash left by the retreating glaciers and meltwater. Glacial till deposits vary in thickness across the island and are much deeper toward the southwest end. Soils in the northeastern section are thin and highly organic; on the southwestern end, the soils are deeper, better developed, and less organic.